



EVALUATION AND ANALYSIS OF ASYNCHRONOUS AND SYNCHRONOUS METHODS OF ONLINE TEACHING OF MEDICAL LABORATORY TECHNOLOGY COURSE

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ABSTRACT

In response to the global coronavirus pandemic, many educational institutions around the world have been closed, which has created a significant learning gap. The training of medical and paramedical students has been crucial for developing a frontline of healthcare workers. Thus, the present study has investigated various synchronous and asynchronous methods of online teaching to enhance the students' understanding and skills through the use of medical laboratory technology.

1. Introduction

Nowadays, computers and internet networks have become critical components of our daily lives, and thus the education sector has made significant attempts to incorporate new technologies (Javaid et al., 2020; Skulmowski & Rey, 2020). Indeed, it enabled greater information exchange and much more complex computing tasks, launching a comprehensive approach for various advancement contributions (Araya, Dahalan, & Muhammad, 2021). Computer or, more broadly, information technology (IT) system for which computer is part and parcel of such IT system has been used in different industries including online marketing strategies. ; Online education is one of these various advancement contributions. Thus, online education can support the classroom setting, in a hybrid model or even in isolation, with no classroom contact between the teacher and the students being required (Danchikov, Prodanova, Kovalenko, & Bondarenko, 2021). The fully-online model can be further subcategorised into asynchronous and synchronous modules (Li & Zhou, 2021). The former can be considered more of an instructional method, in which students use the internet to interact with their teachers in real-time, which establishes a 'classroom-like feel'. By contrast, the asynchronous ways of learning are interactive processes with no time, place or geographical restrictions, meaning that students and teachers do not need to interact online in real-time. This creates a type of "anytime and anywhere" learning (GULTOM, 2021; Liu, 2021; Sumandiyar, Husain, Sumule, Nanda, & Fachruddin, 2021).

Several researchers have carried out studies to compare online teaching with traditional classroom teaching in various disciplines. Most studies have shown similar levels of efficacy when it comes to online education. Nonetheless, fewer studies have compared synchronous and asynchronous online teaching methods. Most existing studies that have explored this topic have produced controversial findings (Ahmed, McGahan, Indurkha, Kaneko, & Nakagawa, 2021; Casañ-Núñez, 2021; Wichanpricha, 2021; Yang, Li, Liu, & Tan, 2021). For instance, a recent systematic review investigated online teaching in health sciences amongst individuals from medicine, nursing, postgraduate courses, public health and dentistry fields. The findings of this review indicated that, despite facilitating online collaboration between teachers and students, there were several barriers associated with it. Thus, further investigation is required to understand the topic better and enable online education to be integrated more effectively and efficiently into the learning process (Ratten & Usmanij, 2021). As far as the researchers are aware, no existing studies have evaluated the effectiveness of online teaching for medical laboratory technology students (i.e., future laboratory technicians).

Over the last few years, the COVID-19 pandemic has forced educational institutions worldwide to close to control the spread of the virus. This has resulted in the loss of many teaching hours. To address this, researchers have developed training modules that can be used by their graduate-degree students in medical laboratory technology subjects. To ensure that online teaching is effective, the present study will investigate asynchronous and synchronous teaching methods and evaluate how students perceive these methods. This gave the researchers a vital opportunity to prepare educators, teachers and students for the future of education in this unprecedented time. As far as we are aware, this study was the first research that evaluated online teaching in science laboratory education and training.

2. Materials and Methodology

This research took the form of a cross-sectional comparison study and was performed in tertiary care hospital settings. Moreover, it focused on training paramedical students in medical laboratory technology. During the national lockdown, the research was carried out when traditional classrooms were closed, and medical laboratory technology students had to learn online. The institutional ethics committee gave their approval for this study to go ahead. Altogether, 33 students in their first year of the medical laboratory technology graduate course at our hospital participated in the study. The teaching faculty developed two online modules (synchronous and asynchronous) for the biomedical statistics course. The topics that would be covered were stratified according to difficulty level, after which they were randomly assigned to the two modules. Power-point presentations or video lectures were shared with students via WhatsApp in the asynchronous module. Students were able to use the same group chat to ask questions, answered quickly by the faculty. Students were given 24 hours for each topic to read the lecture and sit a written examination. The exam contained numerical questions and multiple-choice questions. Students were given a set amount of time to complete the exam and send the faculty a copy of their answer sheets.

Five live lectures were involved in the synchronous module delivered via an online meeting app at a specified date and time, which the faculty and the students decided. Students could use the app to ask questions during or after the lecture. Subsequently, students had to sit an online examination after studying the topics in this module, which took place at a predetermined date and time. The examination pattern was the same as that for the synchronous module (MCQs and numerical questions). The same teaching faculty that delivered the lectures were tasked with assessing students' performance in this examination.

The teaching faculty created a short online questionnaire to uncover students' opinions and accept the two teaching methods [Table 1]. The questionnaire included clarity of concepts, confidence in answering numerical questions and preferences for online teaching modules. However, no identifiers were included in the survey, which means that students could feel confident in providing their genuine and valid opinions without being recognised. The survey was piloted amongst postgraduate students to ensure that questions were straightforward.

Table: 1 Survey questions employed in the study

Questions
Did the PowerPoint presentation sent to you (asynchronous mode) help you understand the key concepts related to the topic?
How confident were you answering numerical questions about the topic once you had read the PowerPoint presentation?
Did the online lecture (synchronous mode) help you understand the concepts covered?
After the online lecture, how confident are you of solving numerical questions about this topic?
Which lecture format is best in asynchronous teaching (sending lectures for offline reading)?
Do you prefer asynchronous or synchronous online teaching?

3. Results

Altogether, 20 lectures (ten from each module) from the biomedical statistics curriculum were delivered via WhatsApp of the online learning platform, after which students were asked to sit an examination. For the synchronous module, the attendance rate was 92.9%, whilst 90.6% sat the exam. All of the asynchronous lectures were delivered via WhatsApp, although the attendance for this group was not calculated. On average, 91.4% of students in this module completed the examination. Moreover, 31 of the 33 students completed the questionnaire, with the remaining two only partially completed it, and thus their surveys were omitted from the analysis.

3.1 Understanding the Concepts

Most students (96.7%) reported understanding the concepts covered in the synchronous module. However, only 56.7% of students had a fair to clear understanding of the topics covered in the asynchronous module [see Figure 1 and Table 2]. A statistically significant difference was identified between the two modules in this regard ($P < 0.001$).

Table: 2 Comparing student's responses of the understanding of concepts and topics covered in the asynchronous and synchronous modules

Student's response	Asynchronous module (%)	Synchronous module (%)
Concepts not understood	6.67	0.00

Student's response	Asynchronous module (%)	Synchronous module (%)
Could understand only a few concepts	36.67	3.23
Concepts understood fairly	40.00	25.81
Concepts understood clearly	16.67	70.97

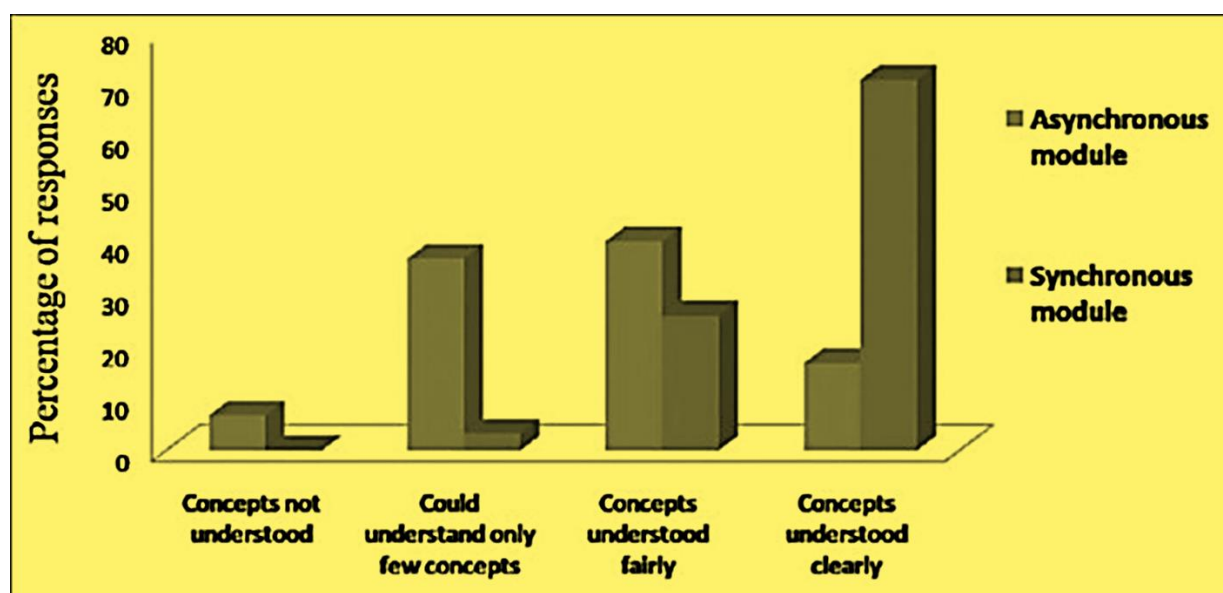


Figure: 1 shows students' response regarding how they understand the concepts taught in the asynchronous and synchronous modules.

3.2 Confidence in Problem-Solving

All in all, 93.5% of students felt confident in answering some or all the numerical questions in the examination of the synchronous module. In contrast, only 74.2% of students felt the same confidence level in answering the asynchronous module's examination questions [Table 3 and Figure 2]. This difference is statistically significant ($P = 0.039$).

Table: 3 Students' responses regarding their confidence in solving problems with the asynchronous and synchronous modules.

Student's response	Asynchronous module (%)	Synchronous module (%)
Not at all confident	3.23	0.00
May be able to solve a few questions	22.58	6.45
Confident in answering some questions but not all	48.39	29.03
Confident in solving all questions	25.81	64.52

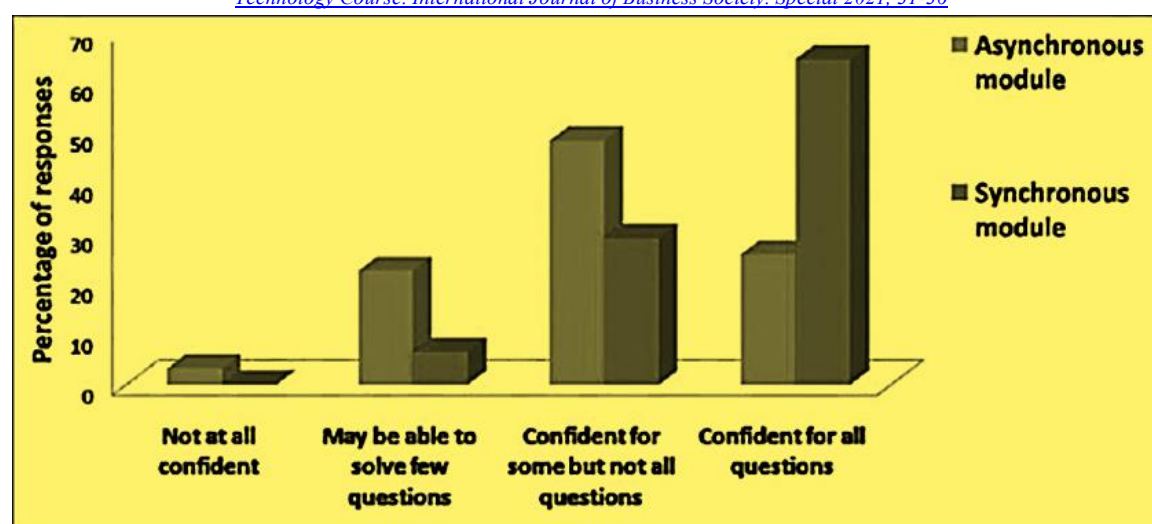


Figure: 2 Students' responses regarding their levels of confidence in solving problems with the asynchronous and synchronous modules.

3.3 Preference for Online Teaching

Most students selected the synchronous module of online education as the preferred delivery method (87.1%). On the other hand, only 12.9% of students preferred the asynchronous module ($P = 0.001$). 77.42% of students preferred video lectures in the asynchronous module, with 22.58% choosing PowerPoint presentations.

3.4 Subjective Comparison of Asynchronous and Synchronous Online Modules

There were several reasons why students favoured the synchronous online teaching module (87.1%). For example, some students reported that it allows them to clarify uncertainties and ask questions or feel better being in a classroom environment. This enhances punctuality and makes students feel more confident in solving problems. Nonetheless, many students also reported that internet connectivity issues occasionally prevented them from attending lectures. Only 12.9% of students opted for the asynchronous module, and they did so for various reasons. For example, some students highlighted the flexibility to view PowerPoint presentations or video lectures numerous times at one's own pace as a prominent advantage. Moreover, the fact that there are no technological requirements for constant connectivity also influenced this decision. However, students generally agreed that synchronous modules better-understood topics to clarify any uncertainties in real-time.

3.5 Examination Performance

For each module, the average examination score was calculated. The average score for topics covered in the synchronous module was 25.3 ± 9.8 , whereas this score was 19.4 ± 8.5 for the asynchronous module. Thus, there was a statistically significant difference between the two averages ($P = 0.0156$).

4. Discussion

In many countries, the shortage of qualified healthcare workers (such as paramedical staff and laboratory technicians) is a common concern. [10] Although governments have made significant efforts to address this problem by increasing the number of seats in current teaching institutions and building new colleges, faculties often lack the skills and resources to teach and train these students. This problem has only worsened during the current coronavirus pandemic, as lockdowns have forced educational institutions worldwide to close. [11] This has opened new doors for only teaching and e-learning approaches. In recent years, information and communication technologies have advanced rapidly, making online education possible. There are two critical types of online teaching, namely synchronous and asynchronous.

Many medical and dental education researchers have compared traditional classroom teaching with online teaching approaches. For example, Abdollahi et al. found that virtual teaching approaches for teaching pathology to medical students were just as successful as traditional ones. Similar findings were revealed by Moazami et al. among dentistry students. [7] Moreover, a meta-analysis was conducted to compare massive open online courses with traditional medicine courses. The findings indicated that investing in online education is critical in preparing for the future of education. [12]. Nonetheless, very few studies have compared the two different types of online teaching, and those that have attempted to compare the two have found mixed results. For instance, a survey conducted with postgraduate dental students revealed that participants rated the asynchronous and synchronous teaching modes equally in student-teacher and student-student interactions. However, the asynchronous format was rated more highly than the synchronous format for learning ability ($P = 0.001$), with higher levels of comfort being reported for the former. The researchers suggest that this preference for

asynchronous teaching may have been caused by a lack of familiarity with the technologies needed to engage in synchronous instruction. On the other hand, a study involving dental hygiene students revealed that the synchronous strategy was associated with higher cognitive presence than the asynchronous method. It is believed that higher levels of cognitive company promote critical thinking, which leads to improved skills (Cai, 2021). A study performed by Knopf-Amelung et al. investigated asynchronous and interactive online approaches for teaching medical students how to carry out screening and brief interventions and how to refer patients for substance misuse treatment. The findings revealed that the online interactive teaching method had a more significant influence on how students perceived their role in preventing substance misuse.

On the other hand, the asynchronous instruction group displayed considerably higher motivation levels during interviews (Ahmed et al., 2021). Meanwhile, a recent meta-analysis found that synchronous online webinars were more effective than asynchronous ones in boosting students' knowledge (Zheng, Bender, & Lyon, 2021). Moreover, a recent systematic review investigating online teaching in health sciences revealed that the key factors motivating individuals to adopt e-learning were the ease and effectiveness of learning and the ability to combine theory and practice. By contrast, other factors such as poor student engagement, lack of self-discipline, insufficient investment in course development, lack of familiarity with technology, and the unsuitability of courses were significant barriers hindering the adoption of e-learning (Zhang, Koseoglu, King, & Aladag, 2021). This study is the first piece of research to investigate and compare the two different types of online teaching approaches amongst medical laboratory technology students. The findings indicate that the synchronous system is more effective in facilitating students' understanding of the concepts covered than the asynchronous approach, increasing their confidence in subsequent examinations ($P < 0.05$). Most students reported feeling confident during synchronous online classes. The key strength of the synchronous approach is that students can interact with teachers and peers in real time. Nonetheless, some students favoured asynchronous learning as it allowed them to study the lectures at their own pace and reread sections of it when needed. These findings are in line with those of Kunin *et al.* Moreover, there are also several limitations associated with online learning highlighted in many studies, such as issues with network and connectivity during synchronous online classes and short interactions with teachers in asynchronous learning approaches.

In this study, students' subjective assessments and preferences for online learning were supported by the examinations performed after each module. The research indicated that the average examination scores after using the synchronous method were significantly higher than those achieved after using the asynchronous mode ($P < 0.05$). This is the first study to compare the two online teaching approaches by objectively evaluating the efficacy of learning.

5. Limitations

The present study has many strengths, the most significant of which is that it highlighted students' readiness to accept online teaching. Moreover, the fact that one teacher can prepare the modules for all asynchronous teaching and prepare the lectures and examinations for the topics covered were also a strong point, as it keeps teaching and assessment formats consistent. Another advantage of this study is that it facilitates more objective evaluations of teaching outcomes, rather than relying on the subjective assessments made by students. Nonetheless, it is essential to note that this study also has several limitations. For example, it is impossible to assess students' practical skills through online learning. Moreover, given that available resources are limited, it was only possible to teach biomedical statistics during this time. Moreover, during online examinations, students can look in their books for the answers, although this is an issue for both types of online learning and thus would not impact the comparisons made between the two.

6. Conclusion

The present work subjectively and objectively evaluated the efficacy of both online approaches to teaching medical laboratory technology students. Overall, the synchronous module scored higher than the asynchronous method. The world is experiencing an unprecedented crisis, and the future looks very uncertain. Thus, students' acceptance of online teaching methods and the preparation of online teaching is likely to be critical in education. However, the use of such approaches in teaching laboratory skills must be further assessed, as more innovative methods will be required to facilitate the learning of such skills via online platforms. Thus, similar studies must be carried out in other medical fields to support the present work's findings further.

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